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Housing Investment in Canadian Macroeconometric Models: An Evaluative Review

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HOUSING INVESTMENT IN CANADIAN MACROECONOMETRIC MODELS: AN EVALUATIVE REVIEW

Prepared for
the Research Division
Policy Development and Research Sector
Canada Mortgage and Housing Corporation

by

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Cat No. NH20-1/17-1985E
ISBN 0-662-13823-6

ABSTRACT

Macroeconometric models of the Canadian economy were first developed in the late 1960s and have been refined and reestimated over the subsequent years. This evaluative review focuses on the treatment of the housing sector in these models. The basic theoretical foundations are reviewed including the integration of stocks and flows, the role of dynamics and the segmentation of the market. On the basis of a summary overview of the models, a number of general observations are presented and conclusions reached with regard to the current status of the models. The study is concluded with a summary of observations and recommendations.

SOMMAIRE

Créés à la fin des années 60, les modèles macroéconométriques de l'économie canadienne ont, depuis, été perfectionnés et réévalués. La présente étude porte principalement sur le traitement du secteur de l'habitation dans ces modèles. On y examine les structures théoriques fondamentales, y compris l'intégration des marchés et de l'écoulement, le rôle de la théorie dynamique et la segmentation du marché. A partir d'un résumé des modèles, on formule un certain nombre d'observations générales et de conclusions quant à la situation actuelle des modèles. L'étude se termine par un résumé des observations et recommandations.

DISCLAIMER

This study was conducted by David K. Foot for Canada Mortgage and Housing Corporation under Part V of the National Housing Act. The analysis, interpretations, and recommendations are those of the consultants and do not necessarily reflect the views of Canada Mortgage and Housing Corporation or those divisions of the Corporation that assisted in the study and its publication.

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ACKNOWLEDGEMENTS

The author wishes to express his appreciation to the custodians and managers of the macroeconometric models in Canada without whose assistance this study would not have been possible. The support, guidance and patience of the officers in the Research Division of the Policy Development and Research Sector of the sponsoring organization also deserve special mention. However, none of these persons bears any responsibility for the remaining shortcomings of the study which, given the nature of the work, must surely remain in each individual model builder's eye.

SUMMARY

The structure of the housing market in Canadian macroeconometric models is evaluated in this review. It is shown that, while a common theoretical framework provides the structural foundation, none of the existing models would appear to contain a satisfactory specification when viewed from existing theory which includes housing in the portfolio of personal assets. The major determinants of housing demand would appear to be income, prices, interest rates, demographics and government policies, while the major determinants of new housing supply, in addition to price, are land, construction and financing costs. Not all models include all of these determinants. Perhaps a surprising finding is that even the "core" housing sequence of approvals to starts to completions to dollars is not a general feature of these models. Flow-feedback effects appear to be generally well handled, but equilibrium-disequilibrium conditions specified as testable hypotheses would seem preferable to the current a priori assumptions. Market segmentation in these models is incomplete and econometric specification of the segmentation decision, which has occupied much of the recent literature, is not considered. In fact, in concentrating on new construction the models largely ignore developments in the existing or resale housing market. The integration of desirable long-term properties into the short-term forecasting models is a relatively new feature of macroeconometric models which is especially important for housing which is influenced both by determinants which are volatile, such as interest rates, and those which change slowly, such as demographics.

RÉSUMÉ

La présente étude évalue la structure du marché de l'habitation représentée dans les modèles macroéconométriques canadiens. Il est démontré que bien qu'un cadre théorique commun serve de base structurelle, aucun des modèles existants ne semblerait contenir une spécification satisfaisante quant à la théorie actuelle qui englobe le domaine de l'habitation dans le portefeuille des biens meublés. Les principaux facteurs déterminants de la demande de logements sembleraient être le revenu, les prix, les taux d'intérêt, des considérations démographiques et les lignes de conduite gouvernementales, tandis que ceux de l'offre de logements neufs, outre les prix, seraient le terrain, la construction et les coûts de financement. Tous ces facteurs déterminants ne sont pas pris en considération dans tous les modèles. Il est peut-être surprenant de découvrir que même l'enchaînement fondamental des étapes approbation - mise en chantier - achèvement - coûts, en matière de logement, ne constitue pas une caractéristique propre à tous ces modèles. Il semble qu'en général, les effets écoulement-rétroaction soient bien maîtrisés; toutefois, les conditions équilibre-déséquilibre, considérées comme des hypothèses vérifiables, sembleraient préférables aux a priori

des modèles actuels. Dans les modèles, la segmentation du marché est incomplète; de plus, on ne tient pas compte de la spécification économétrique liée à la décision de segmenter, qui a pourtant été traitée dans nombre d'études récentes. De fait, étant donné leur concentration sur les logements neufs, les modèles ne tiennent à peu près pas compte du marché des logements existants ou de la revente. L'intégration de caractéristiques souhaitables à long terme dans les modèles de prévisions à court terme représente un élément assez nouveau des modèles macroéconométriques; cette intégration joue un rôle particulièrement important dans le domaine de l'habitation qui subit l'influence à la fois de facteurs déterminants instables, tels que les taux d'intérêt, et de facteurs déterminants plus constants, comme les caractéristiques démographiques.

HOUSING INVESTMENT IN CANADIAN MACROECONOMETRIC MODELS: AN EVALUATIVE REVIEW

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1. INTRODUCTION

Residential construction, although declining in relative importance in recent years, continues to play an important role in the Canadian economy. As indicated in Table 1, expenditures on new housing rose to over $16 billion in 1981. However, in constant dollars these expenditures peaked in 1976 (at over $(1971) 6½ billion) and have since been lower. These trends are confirmed in share data where, as a per cent of gross national expenditure (GNE), housing expenditures rose in the late 1950s and again in the early 1970s to over 5 per cent of GNE. Since 1976, however, the trend has been downward with the figure for 1982 being the lowest recorded over the period covered by these data.

Historically, the growth in this industry has been quite volatile and often quite different from the patterns in other parts of the investment goods sector. Most recent examples are the housing boom of 1976 when growth in business investment

TABLE 1

HOUSING EXPENDITURES IN CANADA, 1947-1982

Year	Current Dollars			Constant Dollars		
	Level ($bil)	Growth (%)	Share of GNE (%)	Level ($1971 bil)	Growth (%)	Share of GNE (%)
1947	0.455	-	3.4	1.085	-	3.7
8	0.659	44.8	4.2	1.342	23.7	4.4
9	0.795	20.6	4.7	1.552	15.6	4.9
1950	0.953	19.9	5.2	1.773	14.2	5.3
1	0.834	-12.5	3.9	1.346	-24.1	3.8
2	0.946	13.4	3.8	1.499	11.4	3.9
3	1.252	32.3	4.8	1.967	31.2	4.8
4	1.412	12.8	5.4	2.237	13.7	5.6
5	1.785	26.4	6.3	2.776	24.1	6.3
6	1.825	2.2	5.7	2.794	0.6	5.9
7	1.669	-8.5	5.0	2.485	-11.1	5.1
8	2.089	25.2	6.0	3.120	25.6	6.3
9	2.133	2.1	5.8	3.190	2.2	6.2
1960	1.794	-15.9	4.7	2.631	-17.5	4.9
1	1.789	-0.3	4.5	2.602	-1.1	4.8
2	1.854	3.6	4.3	2.704	3.9	4.6
3	1.959	5.7	4.3	2.794	3.3	4.5
4	2.382	21.6	4.7	3.264	16.8	5.0
5	2.634	10.6	4.8	3.413	4.6	4.9
6	2.605	-1.1	4.2	3.168	-7.2	4.2
7	2.809	7.8	4.2	3.229	1.9	4.2
8	3.253	15.8	4.5	3.702	14.6	4.5
9	3.845	18.2	4.8	4.175	12.8	4.8
1970	3.500	-9.0	4.1	3.718	-10.9	4.2
1	4.816	37.6	5.1	4.816	29.5	5.1
2	5.820	20.8	5.5	5.432	12.8	5.4
3	7.387	26.9	6.0	5.996	9.8	5.5
4	8.776	18.8	5.9	5.935	-0.5	5.3
5	9.232	5.2	5.6	5.503	-7.3	4.9
6	12.321	33.5	6.4	6.564	19.3	5.5
7	12.806	3.9	6.1	6.152	-6.3	5.1
8	13.523	5.6	5.9	6.042	-1.8	4.8
9	14.144	4.6	5.4	5.873	-2.8	4.5
1980	13.993	-1.1	4.8	5.512	-6.1	4.2
1	16.147	15.4	4.9	5.821	5.6	4.3
2	12.734	-21.1	3.7	4.455	-23.5	3.5

Source: Department of Finance Canada, Economic Review, April 1983, Reference Tables 3, 4, 5 and 6.

declined, and the business investment boom of 1979-80 when the growth in housing investment was negative (in real terms). Consequently, there appears to be a number of features of housing investment in Canada that make it quite different in behaviour and performance from other parts of the investment goods sector and from the economy in general. As a result, attempts to understand and explain the macroeconomic performance of the housing industry in the post-war Canadian economy have included traditional general macroeconomic determinants (such as per capita income and interest rates) together with variables that are unique in their impact on the industry. These latter variables include the myriad of government policies that have been directed at the industry over the post-war period (see Smith, 1981).

Most research in this area has concentrated on the determinants of housing starts and, following Smith (1970) and others, has acknowledged both the similarities and the differences in the determination of single and multiple unit starts. These data, presented in Table 2, indicate that total housing starts peaked in 1976 with an approximate 50/50 division between singles and multiples. Moreover, this was a peak year for both singles and multiple starts, although multiple starts had been at similar levels for a number of previous years. On average, singles comprised approximately 48 per cent of total starts over the 1970s which represents a decline from the almost 70 per cent average of the 1950s. Information on housing completions is also available and, not surprisingly, tends to follow housing

TABLE 2

HOUSING STARTS AND COMPLETIONS BY TYPE IN CANADA, 1949-1982

	Starts			Completions		
Year	Single	Multiple[a)]	Total	Single	Multiple[a)]	Total
1949	71425	19084	90509	68966	19267	88233
1950	68675	23856	92531	68685	20330	89015
1	53002	15577	68579	60366	20944	81310
2	60696	22550	83246	55967	17120	73087
3	70782	31627	102409	68916	27923	96839
4	78574	34953	113527	71760	30205	101965
5	99003	39273	138276	90553	37376	127929
6	90620	36691	127311	95656	40044	135700
7	82955	39385	122340	81096	36187	117283
8	104508	60124	164632	96830	49856	146686
9	92178	49167	141345	95455	50216	145671
1960	67171	41687	108858	78113	45644	123757
1	76430	49147	125577	76171	39437	115608
2	74443	55652	130095	75593	51089	126682
3	77158	71466	148624	71585	56606	128191
4	77079	88579	165658	76225	74738	150963
5	75441	91124	166565	75104	77933	153037
6	70642	63832	134474	73858	88334	162192
7	72534	91589	164123	73631	75611	149242
8	75339	121539	196878	74640	96353	170993
9	78404	132011	210415	78584	117242	195826
1970	70749	119779	190528	66615	109212	175827
1	98056	135597	233653	82978	118254	201232
2	115570	134344	249914	106508	125719	232227
3	131552	136977	268529	122696	123885	246581
4	122143	99980	222123	129704	127539	257243
5	123929	107527	231456	113409	103555	216964
6	134313	138890	273203	128623	107626	236249
7	108403	137321	245724	117792	133997	251789
8	110029	117638	227667	106195	140338	246533
9	109117	87932	197049	112105	114384	226489
1980	87721	70880	158601	90720	85448	176168
1	89071	88902	177973	98412	76584	174996
2	54457	71403	125860	54720	79222	133942

Note: a) Semi-detached, duplex, row and apartment housing.

Source: Department of Finance Canada, Economic Review, April 1983, Reference Table 23.

starts with a short lag. This is illustrated by the fact that the peak in housing completions occurred in 1977 one year after the peak in housing starts.

These data - housing investment, starts and completions - form the core of almost all macroeconometric models of the post-war Canadian housing industry. They are the primary summary macroeconomic indicators of the behaviour and performance of the industry. As suggested they are not independent indicators, since completions depend on starts (with a lag) and expenditures are obviously related to completions. Consequently, not all macroeconometric models include all of these variables. In some models information on completions is ignored with expenditures being directly related to starts (with a lag), while in other cases building permits issued (or approvals) are used as a "front-end" (or leading) indicator for explaining housing starts. Nonetheless, as will be demonstrated below, the core of all macroeconometric models of the Canadian housing industry is very similar and primarily centres on "explaining" the data outlined in Tables 1 and 2.

Understanding the performance of the industry, or indeed any economic behaviour, requires the development of appropriate economic theory (or theories). As with most goods and services sold on an open market in developed western economies, the "laws" of supply and demand are usually used as a basis for the specification of the housing market. This market does, however, possess a couple of unusual characteristics. On the

supply side, at least over a short period, supply is relatively fixed or inelastic since it takes time to augment the housing stock. On the demand side the consumption of housing (or shelter) "services" is not the only motive for demand since, especially under conditions of uncertain inflation, housing can be used as an investment asset as well. For owner-occupiers it may perform both purposes, but for "landlords" the latter is clearly the dominant source of the housing demand.

The purpose of this study is to provide an evaluative review of the development and treatment of the housing industry, particularly housing investment, in Canadian macroeconometric models. Such models have the "advantage" of having confronted the chosen theory with the observed "facts" of the Canadian housing market over some time span, usually during the past three decades (see Tables 1 and 2). Nonetheless the same observed facts may not necessarily be able to distinguish between alternative theories and some observed facts may remain unexplained by the range of theories examined to date. A review of the approach adopted in a number of different models can, however, suggest which approaches appear to have been, on average to date, the most successful in accounting for the observed behaviour in the Canadian housing industry. This can assist in the understanding of the likely structure and working of the industry from a macroeconomic viewpoint and, perhaps, in the formulation of public policy towards the industry. In addition, the quantitative estimates provided by macroeconometric models can indicate not

only the direction but also the magnitude of likely responses to alternative policies or other exogenous shocks.

In the context of these models, macroeconomic theory suggests that housing is likely to incorporate one of the crucial links between the monetary and the real sides of the macroeconomy. The use of monetary policy to influence interest rates and the impacts of interest rates on, especially longer term, investment and hence aggregate demand provides an important part of the complex simultaneity that characterizes a modern western macroeconomy. In this sense, therefore, the housing industry plays a crucial role far beyond its own domain - and this provides a further reason for reviewing the formulation of this industry in Canadian macroeconometric models.

This report commences with a review of the relevant theoretical foundations that provide the bases for the specification of the relationships to be tested. A number of issues raised in the empirical estimation of the relationships is also presented. This is followed by a brief overview of the development of Canadian macroeconometric models. A summary of the empirical results for the housing industry in Canadian macroeconometric models is then presented, followed by an evaluation of the strengths and weaknesses of existing results and some observations on the use of alternative approaches to housing industry modelling in Canada. A concluding section summarizes the main findings of the report and develops a series of recommendations based on these findings.

2. THEORETICAL FOUNDATIONS

Housing, like most commodities in modern western economies, is sold on a market in which a price gets established. The market price, be it a selling or a rental price, reflects a multitude of factors. In the traditional theory of commodity pricing these are described by demand and supply schedules. As previously noted, however, this market does possess a couple of unusual characteristics. On the demand side the consumption of housing (or shelter) "services" does not constitute the only motive for demand since housing also is an important "asset" in the consumer's and investor's portfolio. On the supply side, the difficulties of augmenting the housing stock at least over a short period of time, mean that the supply is relatively fixed or inelastic in the short run. With these characteristics in mind the foundations of these economic theories are briefly reviewed since they provide the bases for the specification of the relationships to be tested.

2.1 Consumption Theory

The basis for consumption theory is an income constrained utility maximizing framework from which the demand for housing (denoted HC) can be derived. It can be shown to be negatively related to the price (P) with the position of the relationship influenced by a multitude of additional factors $(XC)^{1}$, such as real per capita disposable income, the prices

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1. XC denotes a matrix of consumption determinants. Similar notation will be used throughout this report.

of competing and complementary commodities, the size and age composition of the population, etc. This relationship can be summarized as

$$HC = f(P,XC). \qquad (1)$$

Ceteris paribus, an increase in the housing price will reduce housing demand and vice versa, while an increase in real income will increase housing demand and vice versa. Increases in the prices of competing goods (e.g. automobiles) may increase housing demand, while increases in the prices of complementary goods (e.g. appliances) may have the opposite effect. Several additional factors (in XC) may also influence housing demand.

For this relationship to be the basis for the determination of housing investment requires an excess supply of housing at the going price. Only under these conditions can a demand-oriented theory alone provide a satisfactory basis for empirical work. For examples of the consumer demand approach to housing see Carliner (1973), De Leeuw (1971), Maisel (1963) and Polinsky and Ellwood (1979) for the U.S., and Oksanen (1966) for Canada.

2.2 Portfolio Theory

Although much of the demand for housing is undoubtedly related to consumption (that is, shelter), housing also represents by far the major asset in most families' portfolios (Uhler and Cragg, 1971). The use of housing for "inflation protection" or "capital gains" generates yet a further demand component

which merits additional consideration to the pure consumption motive (see Hendershott and Hu, 1982; McFadyen and Hobart, 1978 and Schwab, 1982). The exact nature of such demand (denoted HP) can be conveniently described within the context of portfolio theory and depends on the relative returns to all alternative assets in the portfolio (XP); that is,

$$HP = g(XP). \qquad (2)$$

This approach has been recognized in the context of the supply side of the housing market (with respect to mortgage funds - see Smith, 1970) but hitherto has been largely neglected on the demand side. Although still in its formulative stages (Henderson and Ioannides, 1983), it is likely that any determination of housing investment which ignores this influence will be unable to adequately account for the observed behaviour of the Canadian housing market, especially in the recent inflationary times. Note, once again, that for a demand-oriented theory to be the basis for the explanation of housing investment requires an excess supply of housing.

2.3 Production Theory

Traditional economic theories of market supply are derived from individual firm cost minimization or profit maximization constrained by the existing technology. Market supply is then a summation of the supplies of the individual firms. This theory shows that the incentive to supply housing (HS) is also

influenced in part by price (P) but in a positive manner. Increased sales or rental prices will spur further investment in housing as the increased potential stream of future returns increases its profitability. Other factors (XS) will also influence housing supply - such as the costs of production including the availability of finance. This relationship may be summarized as

$$HS = h(P,XS). \qquad (3)$$

For this relationship to be the basis for the determination of housing investment requires an excess demand for housing at the going price. If this unsatisfied demand is not the norm then this theory alone cannot provide a satisfactory basis for empirical work.

2.4 A Demand-Supply Framework

Traditional economic theory suggests that the market-clearing price (denoted P*) and quantity (denoted H*) of housing will be established when total demand (denoted HD) equals supply; that is, when

$$HD \equiv HC + HP = HS \qquad (4)$$

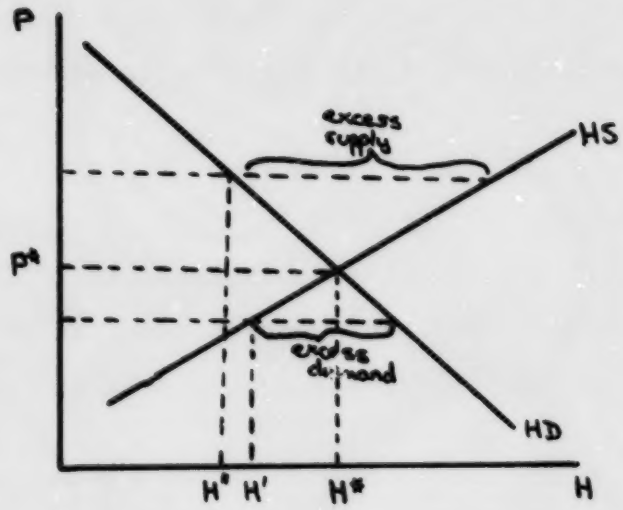
By substituting equations (1) through (3), this implies

$$HD \equiv f'(P,XC,XP) = h(P,XS) \equiv HS \qquad (4a)$$

(where f' represents a combination of the functions f and g) which can be solved for P* (and hence H* - see below) as a

function of XD, XP and XS. This is the market equilibrium solution.

If for various reasons the market does not clear and is characterized by excess demand at the going price, then the supply schedule determines the quantity (H' in the following diagram), while if it is characterized by excess supply at the going price then the demand schedule determines the quantity (H" in the following diagram).[2] The problems associated with dis-equilibrium in the housing market have been explored by Fair (1972, 1973) and others.



In practice the integration of these various influences has often been accomplished using a reduced-form specification. To illustrate this concept first consider the housing supply equation (3) and rewrite it as:

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2. For expository convenience, the demand and supply schedules are assumed to have the traditional slopes. Note that HS will be relatively inelastic (that is, vertical) in the short-run and become more elastic (that is, flatter) as the housing stock can be augmented over time.

$$P = \tilde{h}(HS, XS), \tag{3a}$$

where $\tilde{h}$ represents an inverse of the functional form h, and substitute for P into the demand equation (4a) to obtain

$$HD = \tilde{f}'(HS, XS, XC, XP), \tag{5}$$

where $\tilde{f}'$ represents the substitution of $\tilde{h}$ into f'.

If HD = HS = H* (say) then this can be written as

$$H^* = f''(XS, XC, XP) \tag{6}$$

which specifies that the equilibrium quantity of housing is determined by the exogenous influences contained in each of the three theories. Brady (1973) used this approach in an examination of the U.S. residential housing market. Note that price does not enter this reduced-form equation[3] — it would be relevant only when either the supply or the demand curve is estimated separately.

The basic theories outlined above require additional elaboration and modification before they can be used as a basis for satisfactory empirical work. Such refinements raise a number of important issues, especially in their application to the housing market. These issues are discussed in the following sections.

2.5 The Integration of Stocks and Flows

Housing, being a durable good, lasts for a long time and hence a stock is accumulated. New investment in housing represents an augmentation to the existing stock of housing and

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3. A reduced-form equation, by definition, specifies an endogenous variable (here P* or H*) as a function of exogenous variables only.

hence is a flow (over a specified period of time, such as a year). Since it is new investment[4] rather then the resale of the existing stock that represents current production, thus contributing to the gross national output and hence employment, etc. in the economy, macroeconometric model builders have tended to concentrate on this variable.

Under these conditions the consistent treatment of stocks and flows becomes a potentially important issue. If housing stocks do not appear in a model the above theories may be interpreted as the demand for and supply of new investment. But if stocks do appear in a model then an explicit mechanism for integrating stocks and flows is necessary (Italiano, 1983). By far the most popular integration approach in empirical economics has been the stock-adjustment theory in which comparison of a demand-determined desired stock with the previous period's actual stock provides an estimate of the stock shortfall (or excess) which can then be translated into positive (or negative) net investment using a supply theory (e.g. Beebee, 1972; Hanushek and Quigley, 1979 and Smith, 1970). Note that this approach permits disequilibrium in the housing market.

Note, also that the housing stock depreciates and a certain amount of investment in housing is for replacement

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4. Note that this is defined as gross fixed capital formation in residential construction in the National Income and Product Accounts, and hence includes both investment for augmentation and for replacement purposes (see below).

purposes the amount of which, in major part, will be determined by the size, age and quality of the existing housing stock. This replacement investment together with the new investment represents total (or gross) investment in housing.

In terms of the previous notation this approach can be summarized as follows. First, desired total housing demand (denoted HDD) can be obtained using equation (4a) as

$$HDD = f'(P, XC, XP).$$

This can then be compared with the existing housing stock (denoted $\overline{HS}$) to obtain a measure of excess demand or excess supply ($HDD-\overline{HS}$).[5] The suppliers of new housing are then assumed to respond to this disequilibrium measure by making up all or some proportion of the excess demand, or by limiting their supply of new housing to below replacement if an excess supply exists. A simplified version of this approach is often used wherein both the supply response and the level of replacement are assumed proportional to the determining variables; thus actual housing supply in any period becomes:

$$HS = \rho(HDD-\overline{HS}) + \delta\overline{HS} \qquad (7)$$

where ρ is the (constant) speed of adjustment ($0<\rho<1$) and δ is the (constant) rate of depreciation. Note that if equilibrium prevails in the housing market ($HDD = \overline{HS}$) investment is limited to replacement needs ($\delta\overline{HS}$). Under conditions of excess demand ($HDD - \overline{HS} > 0$) investment exceeds replacement needs while under

5. Time subscripts are introduced in the following section 2.6.

conditions of excess supply (HDD - $\overline{HS}$ < 0) it is less than replacement needs. Finally, note that ceteris paribus a disequilibrium can only be removed completely when $\rho=1$; in the "usual" case when $\rho < 1$ the equilibrium will be approached asymptotically over time.

A major shortcoming of this approach is the assumed constancy of the parameters, especially ρ. It is much more likely that these parameters will vary with economic conditions - as is suggested, for example, for ρ by equation (3) above.

2.6 The Role of Time

As previously noted, housing investment, measured in dollars (per quarter or per year), obscures the time lags inherent in housing construction. Besides the inevitable lags in the decision process, additional time is taken in converting the decision into a completed unit. First, approval must be sought from the relevant authorities; this is followed by a housing start and, finally, by a housing completion. Consequently, up to three stages of housing construction can be considered which are related as follows:

$$\text{Approvals} \rightarrow \text{Starts} \rightarrow \text{Completions(\$)}.$$

Since completions are related to previous starts, and starts to prior approvals, there is considerable role for the use of lagged relationships in modelling the housing market. Note that approvals and starts are usually recorded in terms of the numbers of units whereas completions may be either in terms of units or in dollars (housing investment), the latter (as noted)

being the ultimate objective of most macroeconometric models.

Time lags also play an important role in the integration of stocks and flows since housing completions (denoted HCO) represent a net addition to the existing stock of housing (denoted $\overline{HS}$). Consequently, if $\overline{HS}_{t-1}$ represents the housing stock at the end of the previous period (denoted by the subscript t-1) and HCO_t denotes the number of units completed over the current period (denoted by the subscript t), then the housing stock at the end of the current period is defined as

$$\overline{HS}_t \equiv \overline{HS}_{t-1} + HCO_t - HDE_t \tag{8}$$

where HDE_t denotes the demolition (or depreciation) or removal of housing units over the same time period. Under the simplification that the depreciation rate is constant, that is

$$HDE_t = \delta\overline{HS}_{t-1} \tag{9}$$

equation (8) becomes

$$\overline{HS}_t = (1-\delta)\overline{HS}_{t-1} + HCO_t. \tag{8a}$$

This is an identity relationship which appears explicitly or implicitly in all macroeconometric models.

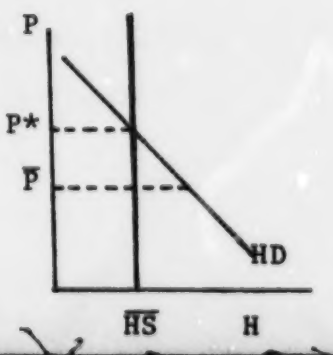
Finally, note that "time" can influence the specification adopted for empirical research. Not only is the elasticity of the supply response likely to be greater the longer the time period (see above), but the actual specification employed may be influenced by the primary purpose of the macroeconometric

model. If it is primarily a forecasting model, then the major concern may be with capturing the macroeconomic turning points, whereas if it is primarily a simulation model more concern may be devoted to the longer-run properties. These differences are usually reflected in the choice of the determinants (P, and the components of XC, XP and XS above) and hence different choices may not only reflect differences in perceived market structure but also differences in purpose. This distinction, although perhaps useful in understanding the reasons for differences in macroeconometric models, is rapidly disappearing in the current generation of models (see Section 5 below).

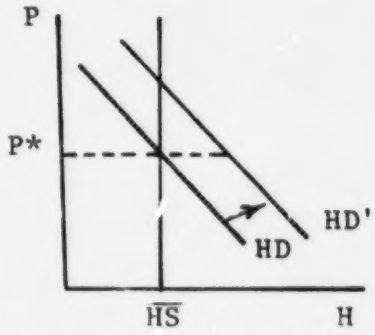
2.7 Dynamics

The general housing market outlined above can provide a useful framework in which to evaluate the dynamics of the market. Two separate views of the dynamics of market behaviour are encompassed within this framework. By definition a supply response for new housing (as distinct from replacement housing) will only be forthcoming when disequilibrium exists in the market; that is when stock demand does not equate with stock supply. For illustrative convenience consider the condition when there is excess demand. In terms of the demand-supply framework outlined in Section 2 this can arise in either of two almost polar cases:

Case I: In the cases where prices are "sticky", excess demand may be the result of the existence of sticky price ($\bar{P}$) below the equilibrium price (P^*). This creates upward pressure on prices which, ceteris paribus, initiates a housing supply response with the ultimately



resulting equilibrium price likely lying between $\bar{P}$ and P* depending on the "stickiness" of the response.



Case II: In the cases where prices are flexible, prices adjust rapidly to equate demand with the inelastic housing stock. Under these conditions new housing construction will only be initiated when an increase in demand (from HD to HD') creates an excess demand at the previous equilibrium price (P*) thus creating upward pressure on housing price which, ceteris paribus, initiates a housing supply response resulting (as before) in an increase in both price and housing stock.

These supply responses will continue so long as the condition of excess demand persists. Once it is eliminated, the supply response is governed by replacement demand only. Under a condition of excess supply, the supply response will be even less than the amount necessary to replace the worn out housing stock.

In all cases the speed of the supply response is determined by cost conditions. If the increasing price is accompanied by increasing costs (of land construction and financing) then the response is likely to be slower than if it is unaccompanied by cost increases. Moreover, the expectations of future price and cost changes potentially play an important role in the determination of the response speed.

These illustrative cases can provide a useful framework in which to examine the dynamics of a macroeconometric model. As with many current models in macroeconomics, the dynamic behaviour reflects the assumed stickiness in prices. In Case I above, the dynamics are primarily determined by the supply response whereas in Case II above, it is likely that the demand behaviour dominates the dynamics of housing investment. In another context, Case I could be viewed as essentially the short-run dynamic behaviour while Case II could be viewed as the long-run dynamic behaviour. In fact, the observed dynamic behaviour is likely to reflect a mixture of these almost polar cases. Not surprisingly this is reflected in the structures of Canadian macroeconometric models which tend to include both demand and supply variables in their set of explanatory variables (see Section 4.3).

One important implication of the above arguments, however, is that a macroeconometric housing model should have the ability to handle both equilibrium and disequilibrium situations; that is, it should be possible to generate gross investment above, equal to or below replacement needs depending on the macroeconomic environment. This <u>may</u> be particularly important in accounting for the recent declines noted in the Canadian housing industry (see Tables 1 and 2). Models which implicitly assume that prices are "sticky" may find it more difficult to explain recent history, especially if the slowdown is demand initiated.

2.8 Market Segmentation

As noted by Beebee (1972), Italiano (1983) and others, the housing market in Canada and elsewhere is, in practice, a host of regional housing markets. Not only is the housing stock (or supply) geographically immobile, but transportation time and costs, occupational immobility, personal preferences, etc. also limit the substitutability of households (or demand). Consequently it is conceivable that the country may be characterized by disequilibria in numerous regional housing markets yet appear to be in equilibrium when viewed from a national perspective. Since the purpose of this study is to review national macroeconometric models it is worth noting that in order to consider one national housing market, the (usually implicit) assumption is that the various submarkets respond similarly to the determining economic variables and hence aggregation is possible.[6]

Market segmentation also occurs within a single local market. A housing unit may be classified as either owned or rented and, as previously noted, as either a single or part of a multiple unit complex (semi-detached, duplex, row or apartment housing). In these cases some degree of substitutability may be possible but it is likely that this decision may itself be influenced by economic variables as well as preferences (see Li, 1977; Henderson and Ioannides, 1983 and Weiss, 1978). Moreover

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6. For a technical discussion of aggregation bias in housing markets see Smith and Campbell (1978).

the composition of the housing stock may well affect the flow variables and hence the dollar expenditures. For example, it may be easier and cheaper to satisfy an excess demand in the rental market by building more multiple units than by conversions from the owned market or by building more single units. Macroeconometric models may identify all, some or none of these segmentations. Note that the introduction of these types of segmentation requires not only a specification of the segmentation decision, but also the calculation of separate stocks along the lines of equation (8) with the additional inclusion of net conversions.

2.9 Summary

This section has provided a review of the theoretical foundations from a macroeconomic viewpoint, together with an outline of a number of important issues when the theory is refined for application to the housing market. The focus has been on the possible dependent variables in macroeconometric models - discussion of the independent or explanatory variables (the components of XC, XP and XS) is left to Section 4. This is preceded, in the following section, by an overview of the general characteristics of Canadian macroeconometric models which will form the basis for the detailed comparative review presented in Section 4.

3. CANADIAN MACROECONOMETRIC MODELS

Macroeconometric models of the Canadian economy were first developed in the late 1960s, primarily in institutions supported by "public" funds with the results appearing in the "public" domain (e.g. Choudhry, et al., 1968, 1972; Helliwell, et al., 1969; Jump, 1972 and McCracken, 1973). These may be conveniently classified as the "first generation" of Canadian macroeconometric models. By the mid-1970s these models generally were being refined and reestimated and a new or "second generation" of Canadian macroeconometric models appeared[7] (e.g. Bank of Canada, 1976; Helliwell, et al., 1971; Economic Council of Canada, 1979 and Sawyer, 1974, 1976). At the same time new models were being developed both in the public and in the private sectors (e.g. Institute for Policy Analysis,1978b or Jump, 1979; Conference Board of Canada, 1977 and Jacobson, 1978). Over the late 1970s and early 1980s numerous further refinements and reestimations of these models have taken place, and, in some cases, both new versions (e.g. Bank of Canada, 1980a, 1980b and London and Stokes 1982) and new models (e.g. CHASE, 1982) have appeared in both the public and private sectors. Although the distinction is somewhat blurred, this might be conveniently referred to as the "third

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7. In some cases this was clearly incorporated into the mnemonic titles such as CANDIDE 2.0 and RDX2 (see below).

generation" of Canadian macroeconometric models. A general characteristic of these latter models is the inclusion of the inflationary period of the mid- to late-1970s into their data-bases and estimated structures.

Table 3 provides an alphabetical listing of these models and their major characteristics. Eight different organizations are identified as being associated with macroeconometric model building in Canada, four in the "public" sector (Bank of Canada, Department of Finance Canada, Economic Council of Canada and University of Toronto) and four in the "private" sector sector (Chase Econometrics Canada, Conference Board of Canada, Data Resources of Canada and Informetrica Ltd.)[8] Within the "public" sector the Bank of Canada's RDX (Research Department eXperimental) models have appeared in three major versions; the Economic Council of Canada's CANDIDE (Canadian Disaggregated Inter-Departmental Econometric) Model has seen two major versions[9], and the University of Toronto's annual TRACE (Toronto Annual Canadian Econometric) Model has been through a number of versions while their quarterly model has appeared in two major versions

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8. Private Sector macroeconometric models developed for in-house use only, such as in Canadian financial organizations (e.g. banks) are not included in this review.

9. Various subversions also exist; see, for example, Bodkin and Tanny (1975) on CANDIDE 1.1 and Economic Council of Canada (1976) on CANDIDE 1.2M.

TABLE 3

CANADIAN MACROECONOMETRIC MODELS: A SUMMARY

Mnemonic Name	Sponsoring Institution[a]	Period of Estimation[b]	Size[c] Variables	Equations	Stochastic Equations	Reference
AERIC	Conference Board of Canada (PR)	Q, 1956-73	647	282	72	Conference Board (1977)
AERIC MTFM		Q, 1961-79	1600a	800a	300a	London & Stokes (1982)
CANDIDE 1.0	Economic Council of Canada (PU)	A, 1954-75	1933	1556	570	McCracken (1973)
CANDIDE 2.0		A, 1953-76	3309	2361	830	ECC (1979)
CHASE	Chase Econometrics (PR)	Q 1962-83	1300a	925a	320a	Private Communication
DRI(1)	Data Resources of Canada (PR)	Q, 1960-78	800a	515	180	Hyndman (1977)
DRI(2)		Q, 1960-82?	835	566		DRI(1983)
FOCUS	University of Toronto (PU)	Q, 1955-75	508	298	156	IPA (1978b,1982)
QFM		Q, 1952-69	110	78	35	Jump (1972)
QFS	Department of Finance Canada (PU)	Q, 1968-80	869	509	151	Department of Finance Canada (1983
RDX1	Bank of Canada (PU)	Q, 1952-65	209	101	50	Helliwell, et al. (1969)
RDX2		Q, 1954-72	702	325	161	Helliwell, et al. (1971); Bank of Canada (1976)
RDXF		Q, 1961-78		403	208	Bank of Canada (1980a and b)
TIM	Informetrica Ltd. (PR)	A, 1955-75	5200a	4200a	750a	Jacobson (1978), Informetrica (1982
TRACE	University of Toronto (PU)	A, 1928-66	232	187	67	Choudhry, et al. (1968,1972)
TRACE MkIIIR		A, 1954-72	320	192	41	Sawyer (1974,1976)
TRACE MkIVE		A, 1954-74	522	303	81	IPA (1978a)

Notes: a) PR = private; PU = public (see text).
b) Q = quarterly; A = annual.
c) Where available; a = approximation.

(QFM - Quarterly Forecasting Model; and FOCUS - Forecasting and User Simulation). Of the "private" sector organizations only the Conference Board of Canada and Data Resources of Canada have, to date, explicitly developed and released more than one version of their model although all organizations are constantly updating and refining the equations that comprise their structure.

The CANDIDE, TIM (which has an intellectual debt to the CANDIDE framework) and TRACE Models are based on annual data, with all the remaining models based on quarterly data. The periods of estimation differ, as might be expected since they reflect the available data at the time of estimation (as indicated by the associated reference). In many cases later versions of these models exist which include more recent data. Most of the models with the exception of the large CANDIDE-type models are of medium size (that is, 500 to 700 variables) with approximately one-half of the variables being determined endogenously. Of these between one-quarter and one-half are determined by stochastic equations with the remaining endogenous variables being determined from non-stochastic identities.

For the record it can be noted that the dynamic properties of most of these macroeconometric models have been explored and, in some cases, compared. Notable examples of such collaborative work among Canadian macroeconometric researchers can be found in de Bever, et al. (1979) and Bank of Canada and Department of Finance Canada (1982).[10]

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10. Additional references can be found in these publications.

This brief overview of the development and major characteristics of Canadian macroeconometric models provides a basis on which to examine the treatment of the housing industry in these models. Such models have the "advantage" of having had to confront the chosen theory (see Sections 2 and 4.1 below) with the observed facts of the Canadian housing market over some time span, usually during the past three decades (see Section 1 and Table 3). A review of the approaches adopted in these models can suggest which approaches appear to have been, on average to date, the most successful in accounting for the observed macroeconomic behaviour in the Canadian housing industry. This is the purpose of the following section.

4. HOUSING INVESTMENT IN CANADIAN MACROECONOMETRIC MODELS

The theoretical foundations outlined in Section 2 above identified the likely dependent variables and their interrelationships in a macroeconometric model of the housing market. The independent or explanatory variables (the components of XC, XP and XS) remained unspecified although their general role was outlined. The first part of this section details a general structure of the Canadian housing market adapted from Maisel (1963) and Smith (1969,1970). The subsequent parts then provide a tabular summary and evaluative review of the characteristics of the housing equations in the models outlined in the previous section. This is followed in Section 5 by a discussion of the evaluation of the group of equations that comprise the housing market in Canadian macroeconometric models.

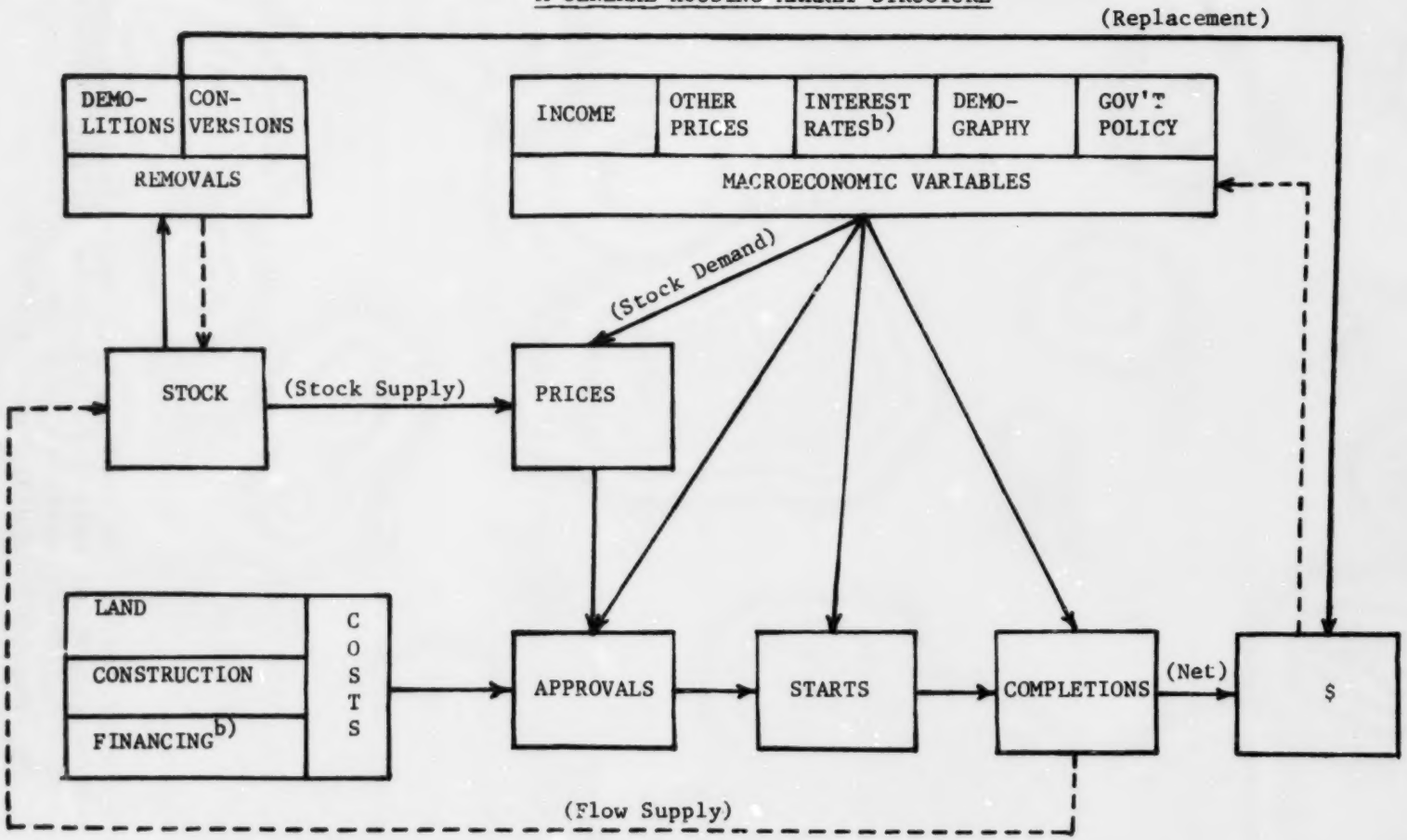
4.1 Housing Market Structure

Chart 1, which has been adapted from Maisel (1963) and Smith (1969,1970), summarizes, in flow chart form, the likely major determinants of housing activity in Canada. The core of this chart is the approvals-starts-completions-investment($) sequence outlined in Section 2. As previously noted a macro-econometric model may include all, some or only one of these dependent variables in its housing equations. This flow chart represents an integrated stock-flow approach to housing activity.

At any given time a fixed stock of housing exists ($\overline{HS}$), which together with the demand for residental dwellings influences housing prices (including rental rates and vacancies). The demand for housing is based on consumer and portfolio theory (equation (5)) with the major explanatory variables (that is, components of XC and XP) likely to be housing price indicators (P), a measure of real income, prices of alternative goods and services, demographic factors, government policies and interest rates, including the cost and availability of mortgage credit. As indicated by the theory, housing price indicators also enter the supply of new housing. Applications for housing approvals likely depend on a comparison of the expected benefits to costs; that is, a comparison of housing price indicators with costs (land, construction and financing, including availability) together with demographic and other explanatory factors that influence expectations about the future path of benefits and costs, and hence future profitability. Housing approvals then get translated into housing starts with a lag (resulting in inventory under construction) and subsequently housing starts into housing completions

TABLE 4

A GENERAL HOUSING MARKET STRUCTURE[a)]



Notes: a) Dashed lines indicate flow feedback mechanisms (see Section 4.4).
b) These variables are closely related.

Sources: Adapted from Maisel (1963) and Smith (1969,1970).

again with a lag. At each of these steps existing macroeconomic conditions may influence the length and shape of the lag and may even result in cancellations of work in progress. Gross housing investment (in constant dollars) is then determined by the number of new units completed and the number of replacement units. Housing completions together with housing removals (demolitions and conversions) then determine the new housing stock (see equation (8)) and the entire process is chronologically repeated.[11] In this sense there is a closing or flow-feedback (Maisel, 1963) of the structure which occurs as a result of the integration of stocks and flows.

Note that this general structure is not only consistent with an integrated stock-flow approach but also incorporates all of the theoretical foundations outlined in Section 2 above, including the previously-identified unusual characteristics embodied in the housing market as a result of it being a durable asset; namely short-term inelastic supplies and portfolio demand considerations. Both demands and supplies are stock determined, but it is the addition to supplies (or the flows) which provides the price sensitivity to housing supply (with a time lag). Time lags enter throughout the process. Also a model of the mortgage market may be easily grafted onto this framework (see Smith, 1969,1970).

Finally, note that this general structure incorporates the previously-mentioned crucial links between the monetary and

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11. In fact the process is in continual chronological flow and a macroeconometric model captures "snapshots" of the process at pre-selected discrete intervals which may or may not correspond to the length of duration of the entire process.

real sides of the macroeconomy. The use of monetary policy to influence interest rates and the impact of interest rates on housing investment and hence aggregate demand provide an important part of the complex simultaneity that characterizes a modern western macroeconomy.

4.2 The Dependent Housing Variables

As noted in Table 4, up to four key dependent housing variables may appear in a macroeconometric model - approvals, starts, completions and dollars, the latter reflecting both net investment and replacement investment. The treatment of each of these variables in each of the Canadian macroeconometric models outlined in Table 3 is summarized in Table 5. A number of general observations can be drawn from this tabular comparison.

First, only a few of the Canadian macroeconometric models use housing approvals (both private and CMHC) information. In the AERIC Model they appear as exogenous variables, whereas in CANDIDE 2.0, DRI(1), FOCUS and RDX2 total (or total private) housing approvals are determined endogenously, usually using a "supply of funds" or financial institution portfolio approach. Note that government policies in the form of CMHC approvals and Bank Act changes often appear as additional determinants in these equations.

By far the most important dependent housing variable in Canadian macroeconometric models would appear to be housing starts. It appears in all models and only the early versions of the University of Toronto models (QFM and TRACE) treat it as exogenous. Of course housing starts can only be related to

TABLE 5

THE ENDOGENOUS HOUSING VARIABLES IN CANADIAN MACROECONOMETRIC MODELS[a)]

	Housing Variables			Segmentation		Gross Investment ($)		
Model	Approvals	Starts	Completions	Singles/Multiples	Method	Net[b)]	Replacement	Other
AERIC	Exog	Endog	No	No	-	T:7QPDL on Starts	Exog	No
AERIC MTFM	No	Endog	Endog	Yes	Both Endog	S:5QPDL on Starts M:7QPDL on Starts	Exog rate	No
CANDIDE 1.0[c)]	No	T:Endog	Endog	Yes	M:Endog S:Residual	S:1Y ident on Comps M:2Y ident on Comps	Endog rate	Exog
CANDIDE 2.0	Endog	Endog	Endog	Yes	Both Endog	S:2YPDL on Starts,etc M:3YPDL on Starts	——Endog[e)]	——
CHASE	No	Endog	No	Yes	Exog ratio	T:7QPDL on both S & M Starts	No	No
DRI(1)	Endog	Endog	No	Yes	Exog or Endog ratio	T:4QPDL on S & 6Q PDL on M Starts	Endog rate	No
DRI(2)	No	Endog	No	Yes	Exog or Endog ratio	T:3QPDL on S & 4Q PDL on M Starts	Endog rate	No
FOCUS	Endog	Endog	No	Yes	Both Endog	T:4QPDL on S & 8Q PDL on M Starts	Endog rate	No
QFM	No	Exog	No	No	-	T:3QPDL on Starts	—— Endog[e)]	——
QFS	No	T:Endog	Endog	Yes	Exog ratio	T:8QPDL on S & 8Q PDL on M Starts	?	?
RDX1[d)]	No	Endog	No	No	-	T:3QPDL on Starts	No	No
RDX2	Endog	Endog	No	Yes	Exog ratio	T:5QPDL on S & 9Q PDL on M Starts	Endog rate	No
RDXF	No	T:Endog	Endog	Yes	Exog ratio	T:6QPDL on S & 6Q PDL on M Starts	No	No
TIM	No	Endog	Endog	Yes	Both Endog	T:Lags on both Starts & Comps(?)	?	?
TRACE	Yes	Endog	Endog	No	-	T:Current S&M Comps	No	No
TRACE MkIIIR	No	Exog	Endog	No	-	T:Current S&M Comps or Endog	No	No
TRACE MkIVE	No	Exog or Endog	Endog	Yes	Exog ratio	T:1Y Lag on S&M Comps. or Endog	No	No

Notes for Table 5

a) Exog = exogenous; Endog = endogenous (equation); No = not included; ? = information unavailable from source reference.

b) S = single; M = multiple; T = total; Q = quarter; Y = year; PDL = polynomial distributed lag (which includes the current period); Comps = completions.

c) See Waslander (1973).

d) See Smith (1970).

e) Combined.

housing approvals in those models in which it appears (e.g. DRI(1), FOCUS and RDX2), but even in these cases other variables often enter the equation as well (e.g. AERIC and CANDIDE 2.0)[12]. The remaining models adopt alternative frameworks to determine starts. These specifications are discussed further in Section 4.3 below.

A third general observation relates to housing completions. This variable does not appear in approximately one-half of the models surveyed in Table 5. In the remaining models where it does appear it is explained by a distributed lag on starts as suggested above (Section 2.6).

As a consequence of these findings it is clear that the approvals to starts to completions sequence in the housing market is not a general feature of most Canadian macroeconometric models since most models lack either the "front end" or the "rear end" variables of this sequence. In fact, the CANDIDE 2.0 Model is the only model of those surveyed in Table 4 which includes all three variables in its housing equations.

With regard to market segmentation, most Canadian macroeconometric models appear to divide the Canadian housing market into singles and multiples. Only the AERIC Model and the earlier QFM, RDX1 and TRACE Models do not include such a segmentation. The methods of segmentation vary, with the most common being an exogenously specified ratio to split the total into its two major components (e.g. CHASE, DRI(2), QFS, RDX2

12. CMHC Approvals may appear in the starts equation as an exogenous variable in some models (e.g. RDX1).

and RDXF). This approach, therefore, only includes the determining economic variables in a very ad hoc fashion. The alternative of explicitly specifying the segmentation decision varies from the very simple (e.g. CANDIDE 1.0) to treating both singles and multiples as separate equations (e.g. AERIC MTFM, CANDIDE 2.0, FOCUS and TIM). Perhaps it is worth noting that this latter approach tends to be associated with the more recent models.

Sixth, an implication of the above discussion is that no other market segmentation variables appear in any of these macroeconometric models. Multiples are not subdivided into the component parts, such as semi-detached, duplex, row and apartment housing, and there has been no attempt to divide the housing stock and decisions into owner-occupied and rental housing in these models. This would appear to limit their usefulness in analyzing many of the policy issues confronting the housing market in Canada which has necessitated separate analyses and development of housing-specific models (e.g. Bossons, 1973, 1978; Brown, 1981; Divic, 1981 and Steele, 1979). Other than "unwieldiness" there would appear to be little reason why such models cannot be incorporated within or linked to a macroeconometric model.

Turning to the "ultimate" housing market variable of most macroeconometric models - housing investment or gross fixed capital formation in residential construction (in constant dollars) - provides yet further insights into the

treatment of the housing market in these models. In the first place, it can be seen from Table 5 that the most common specification for housing investment in Canadian macroeconometric models is a distributed lag (over approximately one to two years) on housing starts rather than housing completions. This reflects the omission of a completions variable in many of the models, but even where such a variable exists the above specification would appear to be common (e.g. AERIC MTFM, CANDIDE 2.0, QFS, RDXF) - and note that these are all relatively "current" models! Only in two models (CANDIDE 1.0 and TRACE) are completions used to determine housing investment in the theoretically traditional manner.[13]

Since housing investment, as measured in the national accounts and hence included in macroeconometric models, is gross investment it includes expenditures on demolitions (replacement) and conversions. It can be assumed that such expenditures are already reflected in the starts (or completions) information in which case no separate explicit treatment of these items is warranted (e.g. CHASE, RDXF and TRACE), or alternatively it can be explicitly included in the investment equation. By far the most common approach is the assumption of a constant depreciation rate (see Section 2.5) and hence the inclusion of a capital stock measure in the investment equation (e.g. CANDIDE 1.0, DRI, FOCUS and RDX2). Nonetheless, this approach presents an interesting conundrum since

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13. TIM apparently uses both starts and completions.

it is not possible to econometrically estimate the depreciation coefficient (or rate) until a capital stock variable has been constructed but any capital stock measure must by definition include a rate of depreciation (e.g. see equation (8a)). One way around this conundrum is to determine the rate of replacement exogenously (e.g. AERIC). Another would be to iterate the estimation of the replacement coefficient until the econometrically estimated coefficient in the investment equation agrees with the rate used to construct the associated capital stock measure.

A final general observation concerns the treatment of a number of relatively small categories that are included in the measurement of housing investment in Canada. These include expenditures on mobile homes, etc. and real estate commissions. Almost all of the macroeconometric models completely ignore these items or take a very simplified approach (e.g. FOCUS). Only the CANDIDE Models make these items explicit, with CANDIDE 2.0 endogenizing them (using the real estate commission rate, etc.).

Of these nine general observations on the dependent housing variables in Canadian macroeconometric models perhaps the most surprising, at least in light of the theoretical foundations (Section 2), is the almost universal adoption of a relationship between housing investment and starts, even when a completions variable is available.[14] Under these conditions the

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14. This feature, although theoretically unattractive, reflects the way in which Statistics Canada, the national economic data collection agency, compiles its data on residential investment.

very existence of a completions variable might seem questionable were it not for the calculation of housing stocks (see equation (8)). This is briefly returned to in Section 4.4 below following a discussion of the explanatory variables appearing in the above equations presented in the following section.

4.3 The Explanatory Variables

The inclusions and interrelationships among the dependent housing variables in Canadian macroeconometric models have been outlined in the previous two sections. This section is devoted to an overview of the other major explanatory variables in the housing equations. These determinants are summarized in Table 4 where they can be conveniently divided into two main categories:

(i) Demand (or Macroeconomic) Variables - which include income, prices of commodities other than houses, interest rates, demographic and government policy variables; and

(ii) Supply (or Cost) Variables - which include land, construction and financing cost variables (all of which may be subject to government policy - see Smith, 1974), together with other variables which affect expectations.[15]

As noted in Section 4.1, given an existing relatively inelastic stock the demand variables determine housing price

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15. In terms of previous notation, these are the components of the matrices XD = [XC, XP] and XS respectively (see Section 2).

indicators (prices, rents, vacancy rates) which, when compared to costs, produce a supply response which ultimately results in housing investment. Note that housing price enters each of these decisions but that investment is ultimately determined by a reduced form relationship that includes all of these variables but excludes price (see Section 2.4).

However both the theoretical and empirical reviews above noted the interrelationships among the dependent housing variables once this process is initiated. The explanatory variables, therefore, are primarily responsible for the initiation of the process. Theoretically this commences with housing approvals, but the empirical review (see Table 5) noted that this variable is missing from most Canadian macroeconometric models and that the most common "initiating" variable is housing starts.[16] It is the equations for these initiating variables that form the basis for the review in this section.

Table 6 summarizes the major explanatory variables in the equation for the key investment initiating variable for each of the Canadian macroeconometric models outlined in Table 3.[17] Once again a number of general observations can be drawn from this tabular comparison.

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16. This can be identified by examing Table 4 and choosing the first endogenous variable from the left hand side for each model.

17. See previous footnote.

TABLE 6

THE EXPLANATORY VARIABLES OF HOUSING INVESTMENT INITIATION IN CANADIAN MACROECONOMETRIC MODELS[a]

Model	Initiating Variable	Price (Sign)	Demand					Supply				
			Income	Other Prices	Interest Rates	Demography[b]	Gov't Policy[c]	Land	Construction	Financing[d]	Other[e]	Comments
AERIC	Starts	No	Yes	No	Yes	Yes	Yes	No	No	Yes	CMHC appr., lagged starts	
AERIC MTFM	Starts	Yes(+)	No	No	No	(Yes)	Yes	——	Yes? ——	Yes	Unemployment rate	() via requirements
CANDIDE 1.0[f]	Starts	No	Yes	No	Yes	Yes	No	No	Yes	Yes	Housing stock	Stock adjustment
CANDIDE 2.0	Approvals	No	No	No	No	(Yes)	Yes	No	No	Yes	CMHC appr. in starts	() in starts
CHASE	Starts	Yes(+)	Yes	No	Yes	Yes	Yes	No	Yes	No		
DRI(1)	Approvals	No	No	No	Yes	Yes	Yes	No	No	Yes	CMHC appr., time, other const'n	
DRI(2)	Starts	No	Yes	No	Yes	Yes	No	No	No	Yes	Relative rental rates	
FOCUS	Approvals	No*	No	No	No	No	Yes	No	No	No	*Vacancy rate, CMHC appr., other const'n	
QFM	Investment	No	No	No	No	No	No	No	No	No	Starts, time	
QFS	Starts	Yes(+)	(Yes)	(Yes)	(Yes)	(Yes)	Yes	No	Yes	No?	US interest rate	() in price equation
RDX1[g]	Starts	Yes(+)	(Yes)	(Yes)	Yes	(Yes)	No	No	Yes	Yes	CMHC appr.	() in price equation
RDX2	Approvals	No	No	No	No	No	(Yes)	No	No	(Yes)	Other appr.	() in starts
RDXF	Starts	Yes(+)	(Yes)	No	(Yes)	(Yes)	Yes	No	Yes	Yes		() in price equation
TIM	Starts	No	(Yes)	No	Yes	(Yes)	No	(Yes)	(Yes)	(Yes)		Stock adjustment; () in desired stock
TRACE	Approvals	No	No	No	No	Yes	No	No	Yes?	Yes	Unemployment rate, stock	
TRACE MkIIIR	Investment	Yes(-)	Yes	Yes	Yes	No	No	No	No	No	Lagged investment or	exogenous completions
TRACE MkIVE	Starts	No	No	No	No	No	No	No	No	No		Exogenous

Notes for Table 6

a) Yes = included in the equation; No - not included; ? = information unavailable from source reference.

b) Income per capita does not qualify for demographic inclusion, but inclusion of housing stock per capita or size of a certain cohort does.

c) Includes Winter Works and MURB programs, changes in write-off provisions and the Bank Act, tax reform, etc. These may affect both demand and supply.

d) Includes interest rates and the availability of funds.

e) Appr. = approvals.

f) See Waslander (1973).

g) See Smith (1970).

First, both the structural and the reduced form approach has been used in the housing sectors of Canadian macroeconometric models. The structural approach is reflected in the inclusion of housing price as an explanatory variable in the supply response (e.g. AERIC MTFM, CHASE, QFS, RDX1 and RDXF) - in these cases, ceteris paribus, increased housing price initiate more housing starts. In fact it is the comparison of prices with costs that initiate the supply response and, consequently, these models also include cost variables in their specifications.[18] Housing price itself is an endogenous variable in most of these models (e.g. QFS, RDX1 and RDXF) and is determined by demand variables. For example, increases in income and/or decreases in mortgage rates can be expected to result in increases in demand[19] and, given an inelastic housing stock lead to increases in housing price. Demographic variables and other prices can also be expected to influence this relationship (along the lines of equation (3a) with HS=$\overline{HS}$). Alternatively, these variables may be used to determine the "desired" stock and a stock adjustment framework (see Section 2.5) employed to translate this into a supply response (e.g. CANDIDE 1.0 and TIM). The reduced form approach is characterized by the inclusion of both demand and supply determinants in an equation that does not include price (e.g. AERIC, CANDIDE 2.0 and DRI). In these cases the initiating supply response is presumed to reflect a resolution of these

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18. In economics parlance, it would be a comparison of price with a user cost variable appropriately measured.

19. Note that decreases in interest rates also reduce financing costs and hence, ceteris paribus, also lead to increases in supply.

various explanatory influences.

But even these two approaches do not account for all of the models in Table 6. Some of the models would appear to be dominantly demand models (e.g. TRACE) while others are dominantly supply models (e.g. AERIC MTFM, CHASE and RDX2).[20] In some cases, the included variables are, essentially, exogenous (e.g. QFM and TRACE MkIVE). In summary, a considerable variety of alternative approaches have been used to model the housing market in Canadian macroeconometric models. Although all can be encompassed within the general framework outlined in Sections 2 and 4.1, very few include all the elements of that framework in an integrated stock-flow approach.

Of the demand variables, income (usually real, per capita) and the mortgage rate would appear to be the most common, with a demographic influence (usually in the form of housing stock per capita) being used in many models. Very few models attempt to explicitly incorporate the prices of other (that is, competing and complementary) commodities into their specifications.

Of the supply variables, financing costs including funds availability would appear to be the most common, with unit construction costs also appearing in a number of models. Very few models attempt to explicitly incorporate land costs into their supply variables.

With the active involvement of governments in the Canadian housing market over the post-war period (Smith, 1981), it is not

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20. The FOCUS Model could also be included here since the vacancy rate is a price indicator.

surprising to see a number of government policy variables appearing in most models. Various policies have been designed to influence both the demand and the supply sides of the Canadian housing market (such as the RHOSP and MURB taxation provisions respectively) and, consequently, these variables can be found throughout the models. Although not apparent from Table 6, there appears to be no commonly accepted set of policy variables with the inclusions varying from model to model.

One policy variable that does appear (exogenously) in some models is CMHC approvals. Although these approvals can be viewed as somewhat "competitive" with private approvals, an exogenous increase is likely to ultimately result in increased housing investment and this response is incorporated in a number of models (e.g. AERIC, CANDIDE 2.0, DRI(1), FOCUS and RDX1).

A glaring omission of all models would appear to be portfolio <u>demand</u> considerations. In a number of cases the portfolio approach is applied to financial institutions to determine the availability of funds (e.g. AERIC, CANDIDE 2.0, DRI and RDX2), but it has not been applied to households to determine the "precautionary or speculative demand" by households.[21] As previously noted, although theoretically still in its embryonic stages, this is likely to be a serious omission when inflation rates are high and uncertain, as in the latter part of the 1970s

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21. These terms, borrowed from Keynes with apologies, refer to inflation protection and capital gains desires respectively.

and early 1980s. This would appear to be worthy of investigation by the current generation of Canadian macroeconometricians.

Perhaps the major conclusion that emerges from these general observations on the choice of explanatory variables for housing activity in Canadian macroeconometric models is that, although the general theoretical foundations of Section 2 provide a useful synthesizing framework, very few models have systematically incorporated all of the features into their estimated model structures. For an "outsider" (that is, non-macroeconometrician) this would appear to provide little solice and might suggest that more than one model should be used when examining quantitative projections and simulations of housing market variables in the Canadian context.

4.4 Flow-Feedback Effects

In addition to the dependent housing variables and the associated explanatory variables, the general housing market structure of Table 4 includes two important feedback effects. First, as noted in Section 2.6, the housing stock identity (equation (8)) explicitly or implicitly appears in all macroeconometric models. This specifies that the housing stock at the end of any period is the stock at the end of the previous period plus completions minus removals over the period. Consequently, both completions and removals which represent the components of gross housing investment also represent the components of an updated capital stock. Since this updated capital stock subsequently impacts

on housing price indicators and hence approvals, etc.[22] a flow-feedback effect is incorporated into the process. Note that this updated capital stock will also influence subsequent removals and hence a further feedback effect via replacement investment is also included.

Table 7 summarizes the housing stock calculations in the Canadian macroeconometric models presented in Table 3. A number of general observations are readily apparent. Wherever a completions variable is calculated in a model it is used in the determination of housing stock (even though it may not appear in the determination of housing investment - see Table 5 and Section 4.2 above). If a completions variable is not calculated, one of two alternative calculations have been used: (i) determine housing stock in constant dollars (e.g. CHASE, FOCUS and TRACE) or (ii) determine the change in housing stock (and hence its level) using a distributed lag on starts (e.g. AERIC, RDX1 and RDX2). If a housing stock variable is not required elsewhere in the model, then no calculation is necessary (e.g. DRI(1)).

There are two main uses of the housing stock variable within the housing sector. The first, noted above (see Table 5), is in the determination of replacement investment. The second, noted in Table 7, is as a housing stock per capita variable capturing the demographic demand pressures on housing price indicators. In addition, it may find uses elsewhere in the model, such as in the determination of potential output, etc.

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22. This occurs, for example, through the inclusion of a housing stock per capita variable which appears (under demography in Table 5) in some models (e.g. AERIC and DRI(1)).

TABLE 7

HOUSING STOCK DETERMINATION IN CANADIAN MACROECONOMETRIC MODELS

Model	Completions[a]	Method[b]	Stock Units[c]	Use[d]
AERIC	No	$\Delta\overline{HS}$=6QPDL on Starts	#	In Starts via Demography
AERIC MTFM	Yes	PIC on S, M and T Comps.	#	In Starts via Demography (requirements)
CANDIDE 1.0	Yes	PIC on S, M and T Comps.	#	In Starts via desired stock
CANDIDE 2.0	Yes	PIC on S and M Comps.	#	In Approvals via Demography
CHASE	No	PIC on $	$	In Starts via Demography
DRI(1)	No	Not calculated?		
DRI(2)	No	From households	#	In Starts
FOCUS	No	PIC on $	$	In Investment
QFM	No	Not calculated		
QFS	Yes	PIC on S, M and T Comps	#	In Price via Demography
RDX1	No	$\Delta\overline{HS}$=4QPDL on Starts	#	In Mortgage Rate via Demography
RDX2	No	$\Delta\overline{HS}$ = 5QPDL on S Starts & 9QPDL on M Starts	#	?
RDXF	Yes	PIC on S, M and T Comps.	#	In Price via Demography
TIM	Yes	?		?
TRACE	Yes	PIC on $	$	Elsewhere in Model
TRACE MkIIIR	Yes	PIC on $	$	Elsewhere in Model
TRACE MkIVE	Yes	PIC on $	$	Elsewhere in Model

Notes:
a) See Table 5.
b) Δ=change in; $\overline{HS}$=housing stock; Q=quarter; Y=year; PDL=polynomial distributed lag; PIC=perpetual inventory calculation (equation (8)); S=singles; M=multiples; T=total; Comps=completions; $=investment(constant $); ?=information unavailable from source reference.
c) #=number of units; $=value of units.
d) There may also be other uses besides the ones noted.

The second feedback effect indicated on Table 4 is the general simultaneity that characterizes all endogenous macroeconomic variables in a macroeconometric model; namely, the feedback of housing investment through the aggregate demand (GNE) identity on to all macroeconomic variables including incomes, interest rates, prices, etc. This includes the typical feedback response alluded to earlier; namely the simultaneous interaction between the real and monetary sectors in all macroeconometric models.

5. MODEL EVALUATION

The previous section presented an evaluation of the individual equation specifications in Canadian macroeconometric models; this section is devoted to evaluating the housing model per se; that is, the combination of individual equations. At the outset it should be noted that it is not the purpose of this report to select the "best" Canadian macroeconometric model from among the set considered. Rather it is to review the approaches adopted in a number of different models in an attempt to indicate which have been, on average to date, the most successful in accounting for the observed behaviour in the Canadian housing industry from a macroeconomic viewpoint.

From this perspective it is also useful to recall the purpose for which the model has been constructed. A model constructed primarily for forecasting purposes is more likely to concentrate on the immediate response (e.g. flow supply response)

or to use a reduced form specification than to adopt a full structural approach. Although perhaps helpful in interpreting the model structures, it would appear to be unwise to emphasize the distinction between forecasting and simulation models since it is rapidly disappearing in the current generation of macroeconometric models. A "good" forecasting model is interpreted to be one with appropriate long-run properties which is also the necessary characteristic of a "good" simulation model. Consequently, models constructed primarily for short-term forecasting are increasingly being used for simulation analyses and, perhaps to a lesser extent, vice versa. A convenience example of the former might be the DRI Models and of the latter the Informetrica Model (TIM).

This means that it is now reasonable to explore the behaviour of the group of equations comprising the housing sector in most macroeconometric models through simulation experiments. This technique can provide a method for housing model evaluation, as distinct from individual equation evaluation.[23] Since flow-feedbacks are an important characteristic of macroeconometric models, it is desirable to incorporate these effects when assessing the performance of an estimated housing model. This technique can also be used to explore the dynamic behaviour in the models and to compare the performance of different macroeconometric models. The response of the dependent housing variables to shocks which are exogenous to the industry can provide useful

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23. This is conducted, of course, using the standard statistics provided in the estimation of individual equations such as R^2, DW statistic , etc.

insights to the performance of the model. Consider the following illustrative examples:

(i) the impact of population growth and aging - These impacts occur via demographic variables in the demand equations. A model that emphasizes the supply response will only capture these effects very indirectly through their impacts on other macroeconometric variables. Note that the impact of population aging on the housing market will only be experienced in those models which incorporate some measure of the age structure. In other contexts this has been shown to be an important influence on the future Canadian housing market (e.g. Brown, 1981).

(ii) the impact of monetary policy - These impacts occur primarily via the interest rates and the availability of funds variables. "Tighter" monetary policy which increases interest rates will increase both the carrying costs for consumers and the financing costs for producers and thus lead to a curtailment of both demand and supply. However, it may also lead to a reallocation of the consumers' and the financial institutions' portfolios towards greater funds available for mortgages.

(iii) the impact of CMHC approvals - Exogenous increases or decreases in the number (or value) of government-assisted, CMHC mortgage approvals will only impact the housing market in the models which include this variable. While this is a relatively common inclusion it is by no means

a universal inclusion in Canadian macroeconometric models (see Table 5). The impacts of other government policies (e.g. changes in the Bank Act, rent controls, etc.) could also be explored in a similar manner. Note, however, that careful consideration should be paid to ensuring that the model includes some type of government budget constraint so that the introduced policy changes are not "costless".

(iv) the impact of tax changes - The tax schedule has been used for numerous government policies directed at the post-war Canadian housing market (see Italiano, 1983 and Smith, 1981). These include changes in capital cost provisions (including the MURB program), the introduction of RHOSPs, the taxation of capital gains on non-principal residences, mortgage subsidization schemes, etc. The extent to which the different models can handle the impact of these various schemes will give some guide to their usefulness in macroeconomic policy analysis.

These and other similar simulation experiments permit the performance of the complete housing model to be examined, both with regard to the expected outcomes and with respect to the dynamic time paths associated with the outcomes. The choice of macroeconometric models for housing analysis in Canada should be based not only on the single equation structures outlined in Section 5 above but also on the complete model performance as evidenced by an examination of the results, including the dynamic time paths, of simulation experiments. Moreover, the same experiment can be applied to a variety of alternative models to explore

the likely outcomes.[24] Such results may also assist with the choice of macroeconometric model for housing industry analyses.

6. CONCLUSIONS AND RECOMMENDATIONS

Canadian macroeconometric models are now entering their "third generation". The treatment of housing investment in these models can be understood within a demand-supply framework modified to incorporate the relative inelasticity of short-run supply and the crucial role of time which, not only specifies the core "approvals to starts to completions to dollars" sequence in residential construction, but also integrates stocks and flows. Net changes to the housing stock are then associated with disequilibrium conditions in the housing market.

This evaluative review of housing investment in existing Canadian macroeconometric models leads to the following observations and recommendations.

1. Overall none of the existing Canadian macroeconometric models would appear to contain a satisfactory specification of the housing sector when viewed from existing theory. Recent advances in economic theory emphasize the role of housing in an individual's portfolio of assets. The precautionary and speculative demands identified by Keynes with respect to financial assets find their identification in "inflation protection" and "capital gains (and losses)" when applied to the housing market. In times of high and/or variable inflation, as has been experienced in

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24. See de Bever, et al. (1979) and Bank of Canada and Department of Finance Canada (1982) for illustrations of this approach.

Canada and elsewhere in recent years, these considerations are likely to lead to important influences on housing demand. The lack of inclusion of a portfolio model on the demand side in these models would appear to preclude a satisfactory analysis of this component of housing demand.

2. Understanding the Role of Interest Rates is the key to any (short term) analysis of housing investment, since interest rates enter both the demand and the supply side of the housing market. As a demand variable, increasing interest (mortgage) rates raises the carrying cost of a home and thus reduces demand. As a supply variable, increasing interest (borrowing) rates raises the costs of construction, reduces profitability and hence supply. The effects are, therefore, reinforcing thus confirming the downward sloping investment function which is so fundamental to Keynesian macroeconomic analysis. Note, however, that it is not just the level of interest rates that may be important. As implied in the first point above, the term structure or relative returns of alternative assets may also be important in determining both the availability of and the demand for mortgage funds. Both of these effects must not be overlooked. In general, Canadian macroeconometric models to date embody a relatively naive view of the role of interest rates on housing activity.

3. Market Segmentation in Canadian macroeconometric models is incomplete. Most models now separate single from multiple unit construction, but none look at different types

of multiple units or separate rental from owner-occupied housing. Moreover, econometric specification of the segmentation decision (such as whether to rent or own), which has occupied much of the recent literature, is not considered. Not only would these features add considerable "richness" to the model, but they may also improve understanding of the operation of the housing market. For example, increased housing demands may be met from conversions from the existing housing stock rather than from new construction.

4. New Construction is the sole focus of macroeconometric models since they are primarily concerned with real output (GNE) growth which represents new production over the period being considered. Consequently, these models are not concerned with developments in the existing or resale housing market (since this represents changes in ownership and not new production of goods or services). Yet conditions in the resale market may well influence developments in the new housing market. This possibility is generally ignored in most models, although vacancy and rental rates may appear in some equations. A better understanding and specification of these relationships would appear to be beneficial.

5. As a consequence of the previous point, the measurement of housing price in these models is reflected by the implicit price index for residential construction expenditures. This may be a poor indicator of inflation in the housing market since it ignores the resale and rental markets. Of course, these housing

"prices" are implicitly incorporated into the consumer price index (CPI) when it appears in the models but, as has been shown in the recent literature (McFayden and Hobart, 1978), even this is less than satisfactory. There would appear to be considerable room for improvement in the treatment of housing prices in these models. (Parenthetically note that the inclusion of capital gains, etc. into the calculation of the CPI goes back to the role of housing as a household asset, as noted in the first point above.)

6. Equilibrium vs. Disequilibrium approaches remain an apparently underresearched issue. Reduced form models generally start from a premise of equilibrium while stock adjustment models start from a premise of disequilibrium. Yet adherents to both approaches can be found in the literature. Other authors (e.g. Fair) have attempted to approach this issue directly but little consensus appears to have emerged. This should be a testable hypothesis rather than an a priori assumption and any housing model should have the ability to handle both situations.

7. Lags: A surprising finding of this study was even the "core" housing sequence of approvals to starts to completions to dollars is not a general feature of most Canadian macroeconometric models. Often starts determines housing investment directly; thus useful lag information is being ignored (which probably can be more usefully captured with quarterly rather than with annual data). This reflects the method of measuring housing investment in Canada, but given this feature, it is even more surprising to find that housing stocks are usually quite carefully updated in

the models so that important flow-feedback effects are not ignored.

8. Flow-Feedback effects appear to be generally well handled in these models. Not only does the housing investment feed back (via the housing stock) to subsequent replacement and net investment decisions, but the simultaneous interaction between the housing and other sectors (such as the mortgage sector) is an essential and desirable feature of these models. These latter feedback effects are lost when the housing sector is modelled in isolation.

9. The Influence of Government Policies on new housing activity is clearly recognized in most Canadian macroeconometric models, but its incorporation appears to be ad hoc at best. The empirical results of the models do not seem to provide a clear indication of which policies have had significant impacts and which have not. Given the myriad of policies and governments that have been involved in the postwar period this might appear to be a "tall order", yet some consistency in empirical research would appear to be an essential guide to future policy-making in this sector.

10. Replacement Investment in housing, that is new construction to replace demolished housing, is treated rather simply in these macroeconometric models. As in most economic analyses, a constant fraction of the existing stock of housing is assumed to be replaced each year. Under these conditions replacement is not related to current macroeconomic conditions, which may or may not be relevant, but more importantly is not even related to

the age (or the quality) of the existing housing stock. Perhaps the simple assumption is adequate for most purposes but careful documentation of this would appear to be a useful exercise.

11. Concluding Comment: Over the decade and a half since they were first developed, Canadian macroeconometric models have become larger and more sophisticated. Previous advances have been incorporated into subsequent versions and the models have become more accessible to the relatively unsophisticated user (facilitated, in part, by the entry of the private sector into the provision of these services). However, perhaps one of the most important advances is also the most easily overlooked, namely the integration of desirable long-term properties into the short-term forecasting models so that both forecasting and simulation can now be done with a single model. No longer is a quarterly model associated with short-term forecasting and an annual model associated with medium-term policy or simulation analysis. This relatively new feature of macroeconometric models is especially important for housing which is influenced both by determinants which may change quickly in the short-term (such as interest rates) and by those which change slowly even over the medium-term (such as demographics). Consequently, in spite of the limitations outlined above, macroeconometric modelling offers an appropriate methodology for quantitative analysis in this sector, and simulation experiments provide a useful technique for evaluating the performance of the group of equations which comprise the housing sector in these models. Moreover, they can be designed to facilitate comparison of the results, including the dynamic properties, of alternative macroeconometric models.

Of course other approaches to the quantitative modelling of the housing market are also possible. The use of cross-section information is well-established (e.g. Bossons, 1973, 1978 and De Leeuw, 1971) although recent econometric work has attempted to combine this with aggregate information (Polinsky and Ellwood, 1979) and time series information (Carliner, 1973). Pure demographic approaches have also been developed (see Brown, 1981 and Divic, 1981) but these can also be accommodated within the macroeconometric framework if desired. A related, but in some senses fundamentally different modelling methodology is provided by systems dynamics (e.g. Forrester, 1973). With its stock-flow relationships and flow-feedback impacts the housing sector is ideally suited to this methodology. Although it has limitations (see Taylor, 1973), models of this type could perhaps provide further insights into the behaviour of this important sector in the Canadian macroeconomy.

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